2001 ANNUAL REPORT

December 1, 2000 – November 30, 2001

The Enhancement of Overall Student Performance Through a Statistics Research Program for Students who are Recruited into Science, Engineering and Mathematics Programs

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1. PROJECT OVERVIEW AS GIVEN IN ORIGINAL PROPOSAL

A primary goal of this project is to improve the quality of science, engineering and mathematics programs at Alabama A&M University (AAMU). Another goal is to increase the number of under represented bachelor degree graduates who are prepared to do graduate work in the sciences. The project proposed to achieve its goals by using a five-fold approach: 1) Recruit high-ability students into a summer enrichment program for recent high school graduates who have committed to major in science, engineering or mathematics (SEM). 2) Provide each recruit with a scholarship provided he/she enrolls in SEM during follow-on fall semester. 3) Require each recruit to take a core of courses in statistics and mathematics while retaining a major in SEM. 4) Have each participant to formulate and execute a statistics research plan and report findings in a well-written report. 5) Have PI to engage in extensive research on student performance at AAMU. We have completed three years and three months of activities and this document provides a summary. The scholarship program supported by this project is known as The Mathematics Scholarship Program (MSP).

2. ACTIVITIES

2.1 Proposed Activities for December 1, 2000 - November 30, 2001 as Described in Original Proposal.

- Recruit 4 additional freshmen students.
- Plan summer activities for recruited students.
- Junior level participants will do preliminary work on capstone project and/or internship assignment. Administrative Assistant will assist students with the location of internship opportunities.
- Select junior level MSP participants who will mentor lower level students.
- In November 2001, MSP Director submits 2000-2001 annual report.

2.2 Phase-down of MSP

The period of performance of this award was August 1998 through May 2001 with an option for two additional years. In November 2001, the AAMU Project Director was notified that the Office of Naval Research (ONR) would focus future Infrastructure Program funding on other important needs such as instrumentation and research. This meant that this Education Program (N00014-98-0764) must under-go a phase-down and was invited by ONR to submit a phase-down proposal which was to cover June 2001 through May 2004. The phase-down proposal was submitted and subsequently funded for above mentioned phase-down period.

2.3 Student Recruitment for Year 2001.

The phase-down proposal did not request funds for student recruitment for this period. Therefore, no new students were recruited in 2001.

2.4 Student-Workers

Five undergraduate student workers (work-study) are employed by the MSP. These students are SEM majors who have been assigned to a variety of duties such as computer lab assistants, tutors in mathematics, statistics or in a physical science. Each student-worker is associated with at least one SEM faculty member who serves as a mentor for the student-worker. Each student devotes between 10 and 20 hours to work activities.

2.5 Summer Internships for Year 2001

This summary of internship activities includes those internships received by any of the twenty-one MSP participants or any of the five additional MSP-supported work-study students. Each of these 26 students attended seminars on resume and research paper preparation. The Administrative Assistant of the MSP compiled a list of internship opportunities (with website addresses), which was distributed to MSP members. The internship list range from individual universities that sponsor specialized internship programs to a website published by The American Statistical Association, which contains many internship announcements. Several students took the initiative to identify

unique research opportunities that are different from those shown above. At least 16 internship invitations were extended. Internship host agencies were Harvard University, Alabama A&M University, NASA, University of Wisconsin, Alabama State University, University of Maryland and three private companies.

2.6 Fall 2001

A total of twenty-one MSP students plus five additional work-study students enrolled for the fall semester of year 2001. At the end of summer 2001, the twenty-one MSP students had an average cumulative average GPA of 3.33. When the five work-study students are pooled with scholarship students, the average GPA for the pool is 3.38. Three of the scholarship students have GPAs that are below 3.00. These three students will receive counseling from the MSP Director.

2.7 Summer Internships for Year 2002

The Administrative Assistant for the MSP is in the process of compiling a list of summer internship opportunities for 2002. When completed, the internship list will range from individual universities that sponsor specialized internship programs to a website published by The American Statistical Association which contains many internship announcements. By October 1,2001, several 2002 announcements had been bulletin-board posted. As of November 1, 2001, three students had submitted applications to agencies such as the Central Intelligence Agency, the National Security Agency and The Joint Program in Survey Methodology at the University of Maryland.

2.8 Project Director's Visits to Other Universities

The Director of the MSP has visited several statistics departments at universities such as the University of Alabama, University of Alabama at Birmingham, Harvard University and most recently, the University of Wisconsin (UW). During each of the visits, the role that AAMU may play in supplying students to the visited graduate program was discussed. Four MSP students participated in the 2001 UW Biostatistics Summer Internship Program where each was associated with a UW faculty mentor. Based on an initial assessment by mentors, two of the above mentioned students

have the interest and aptitude to do well in UW's graduate statistics program. The two students, who are now entering the junior year at AAMU, have been promised graduate fellowships at UW.

2.9 Related Proposals Submitted to Other Agencies

The phase-down notification letter from ONR (see section 2.2) encouraged current holders of ONR infrastructure grants to seek funds from other agencies to expand infrastructure enhancements provided by the ONR Infrastructure grants. The Project Director of MSP has been very aggressive in seeking additional support for research and program development in statistics and statistical applications in scientific areas. The Project Director has submitted a total of three proposals. One proposal being submitted to each of the following: U.S. Department of Agriculture, NIH Small Research Grant Program and the NIMH Minority Research Infrastructure Support Program. Decisions on all three are pending. One additional proposal is under development.

2.10 Administrative Assistant

The MSP has been quite successful in the recruitment of high-quality scholarship and work-study students as well as the identification of student research opportunities. The MSP Administrative Assistant is responsible for coordinating all activities related to the logistics of student affairs. Her activities and duties are listed below:

- Recruit work-study math/science students and prepare administrative paper work for their employment.
- Prepare bi-weekly payroll for work-study students.
- Prepare and process requisitions for tuition, room and board for scholarship students.
- Identify internship opportunities for MSP students and assist in their application process.
- Provide administrative and clerical support to Project Director.
- Developed brochures and newsletters.

- Serves as a liaison to the University Offices of Financial Services and the Office of Research and Development on financial matters related to the MSP.
- Serves in the absence of the Director in matters requiring decisions such as signing of routine intra-institutional papers.
- Perform notary duties for the program.

2.11 Senior Project

Each MSP participant is required to take a three-semester hour Senior Project (MTH 481) research course. While in this course and under the supervision of a faculty mentor, a student conducts research and reports findings in a well-written report. MSP participants who have had at least one internship are in the process of discussing and selecting research topics for MTH 481. It is possible that some students who have internship experience will have their internship mentor of the internship host and an AAMU faculty member to co-supervisor their senior project.

3. DISSEMINATION

The 1998, 1999 and 2000 Annual reports described previous dissemination activities. Since that time, this PI and members of this MSP have shared ideas of this project at several on-campus and off-campus seminars. The following presentations have been made.

- One MSP work-study student presented a paper at the National Conferences on Undergraduate Research (NCUR), Lexington, KY, March 15-17, 2001. This paper has also been accepted for publication in the Proceedings of NCUR. (See Appendix A)
- Two MSP students presented posters at the 2001 NCUR. March 15-17,2001. (See Appendices B and C).
- Temple, Enoch C. (April, 2001)
  Presentation at the University of Wisconsin, Biostatistics Department.

4. APPENDICES A, B, C

The first page of the NCUR student paper and the first page of two poster reports are shown in these appendices.

Appendix A: 1st PAGE OF PAPER PRESENTED AT NCUR

Proceeding of The National Conference
On Undergraduate Research (NCUR) 2001
University of Kentucky, March 15-17, 2001
Lexington, Kentucky

STATISTICAL CLASSIFICATION METHODS APPLIED TO LOCALLY COLLECTED DATA SETS

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Abstract

This paper discusses methods of classifying an object into one of k possible groups based on a single observation of a multivariate vector of p variables. The mathematical justifications for the classification procedures are presented through the use of a single variable (univariate) probability distribution. Two populations were used, each of which has a univariate normal probability distribution. The definition of the probability of misclassification is used to show how the minimization of misclassification probability results in a classification rule that involves the ratio of the two univariate normal distributions. An assumption was made that the univariate classification rule extends to the multivariate case and the paper proceeds to present classification rules for three ($k = 3$) populations that have multivariate normal distributions ($p = 15$). Application of the classification procedure is demonstrated by using two locally collected multivariate data sets. Both sets involve data recently collected with a hand-held reflectometer on three plant species ($k = 3$) grown in experimental growth chambers on the campus of Alabama A&M University. The application of classification rules using this data and problems that were encountered are discussed. The concluding remarks discuss why the reflectance data need filtering treatment.

Keywords: Spectroreflectivity and species discrimination

1. Introduction

In this paper, observations are to be classified into one of three groups under conditions of uncertainty. The classification process will allow a user to observe a p-variate vector, substitute the components of that vector into a discriminant function, and then use the function's output to make a decision as to which of the three populations the observed vector originated. Prior to a derivation of the discriminant function, assumptions are made about the probability distribution of the random vector for each of the three populations. From these three distributions, discriminant functions and classification procedures are developed.

Many of the theoretical concepts presented here were obtained by reviewing fundamental concepts from Johnson and Wichern (1998). The data set used to demonstrate the application of the classification procedure is a collection of electromagnetic reflectance observations on three plant species (lettuce, tomato, and wheat), which were collected by an Alabama A&M University (AAMU) graduate student. The variables in the data set are spectral reflectance percentages at 512 wavelengths. The problem of interest

SOME FORMULAE FOR EVALUATION OF A CLASS OF SINGLE AND REPEATED INDEFINITE INTEGRALS

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Abstract

The integration of the product of two functions is generally performed by the methods of integration by parts and the repeated integration by the successive integration method. In this paper, two formulae are presented for the evaluation of certain types of single and repeated integrals. These fromuale are very efficient and considerably shorter than the traditional methods. They are suitable, especially for manual evaluation of certain repeated integrations. The effectiveness of this method is verified by differentiation.

1 Introduction

Generally the integration of a product of two functions is done by the metod of "Integration by Parts" and repeated integration by "Successive Integration Method". In this note two formulae are presented to evaluate repeated integration which are very efficient and short compared to the traditional method of "Successive Integration". Very often, students of matematics, physics and engineering have to perform repeated intgration in many areas such as solving higher order non-homogeneous differential equations with repeated roots of the characteristic equation, where the forcing functionis is of the type x^m or $x^m e^{ax}$. In case of repeated integration or even in single integration as seen in the Fourier analysis problem, where m is large, it often makes evaluation of the integral very lengthy and laborious. The formulae are developed to evaluate single or repeated integrals, when the integrand is a product of two functions of the form, $x^m f(x)$ where $f(x)$ is any of the following forms:

$$\cos(ax),\ \sin(ax),\ e^{ax},\ \ln(ax).$$

These formulae can be easily applied and are found to be the quickest method for manual calculation for any number of repeated integrals and for any large value of m in just a few steps. Here we did not show the derivation of the formulae; but gave two examples in each case and verified their effectiveness by differentiating the anti-derivatives.

TWO BASES FOR THE COMPLEX BINARY NUMBER SYSTEM

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Abstract

Presently when arithmetic operations involving complex numbers are performed by a computer, the real and the imaginary parts of the numbers are treated separately and they are combined to obtain the final result of the operation. Over the years, attempts have been made to treat a complex number as a single unit in performing all calculations, but has attained a little success. Recently, researchers [5] developed a number system in which a complex number can be written as a single binary number by using complex bases for binary number systems. In this paper, two such bases are proposed, and the relationship of these with existing bases are shown. Arithmetic operations for these new number systems are explored.

1. Introduction

Complex numbers play a very important role in modern science and engineering. It is especially important in most digital signal processing algorithms, like Fast Fourier Transform and the geometric analysis of graphics/image processing. Whenever an operation involving complex numbers is performed by a computer, it deals with the real and imaginary parts separately, the individual results are combined to obtain the final result of the operation. There is a need for some problems in signal and image processing to treat a complex number as a single unit. Moreover, representing a complex number as a single unit reduces the number of arithmetic operations needed for the usual method. Attempts have been made to represent a complex binary number as a binary number with a base other than 2. In this regard, the work of Donald E. Knuth of 1960 [1] can be mentioned. He developed a "quarter-imaginary" number system with base 2j, and analyzed the arithmetic operations using this base without providing any division algorithm. This was a major drawback of this system.

In 1964, Walter Penny developed a complex number system by first using a negative base -4 [2] and then by using a complex number (-1+j) as the base [3]. This system again is lacking in providing any efficient division algorithm. Another attempt was made by Stepavenko [4], using the base $j\sqrt{2}$. Although this system was partially

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14. ABSTRACT

This document summarizes the progress made on grant N00014-98-1-0764 during the period December 1, 2000 – November 30, 2001. The objective of the grant is to recruit freshmen students into science, engineering and mathematics and to do research on student performance assessment. Section 1 gives a statement of the project's goals and methods used to achieve goals. Section 2 provides a detailed description of project activities for year 2001. Dissemination activities are provided in section 3, and section 4 contains the Appendices.

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